REMARKS

The rejections under 35 U.S.C. § 103(a) of:

Claim 1 as unpatentable over U.S. 5,328,855 (Kitabatake et al) in view of U.S. 5,981,057 (Collins), and

Claims 31 and 34 as unpatentable over Kitabatake et al and Collins, in view of WO 99/64892 (Sussmann et al),

are all respectfully traversed.

As recited in Claim 1, an embodiment of the present invention is a single crystal diamond prepared by CVD and having at least one of the following characteristics:

(i) in the off state, a resistivity R_1 greater than 1×10^{12} Ω cm at an applied field of 50 V/μm measured at 300 K;

(ii) a μτ product measured at at an applied field of 50 V/μm and 300 K greater than $1.5 \times 10^{-6} cm^2V^{-1}$ where, μ is the mobility and τ is the lifetime of the charge carriers;

(iii) an electron mobility (μ_e) measured at 300K greater than 2400 $cm^2V^{-1}s^{-1}$;

(iv) a hole mobility (μ_h) measured at 300K greater than 2100 $cm^2V^{-1}x^{-1}$; and

(v) a high charge collection distance greater than 150 μm measured at an applied field of 1 V/μm and 300 K.

Kitabatake et al is drawn to removing defects in diamond crystal by irradiating the diamond crystal with light having a radiation density of more than 0.1 W/cm^2 and efficiently annihilating defects therein, thus forming semiconductor diamond crystals (column 1, lines 44-48). Kitabatake et al discloses further that diamond films have been formed by the CVD method but, for example, n-type semiconductor diamond with sufficient low resistivity for semiconductor device applications was not achieved (column 1, lines 15-22).

The Examiner acknowledges that Kitabatake et al does not disclose single crystal diamond formed by CVD. The Examiner thus relies on Collins.

Collins discloses the formation of diamonds by CVD, which may be single crystal but is preferably polycrystalline (column 2, lines 27-28). The Examiner finds that the single crystal CVD diamond embodiment of Collins meets characteristic (ii) of Claim 1 because Collins includes embodiments for making his CVD diamond that does not include nitrogen. The Examiner then finds that "since no nitrogen was available to the diamond during growth no nitrogen could have penetrated into said diamond and hence the nitrogen impurity level cannot be greater than 300 ppb, which, together with the 'annihilation of defects' and single crystal property, implies the conditions for said characteristic (ii) are met according to Applicants' own specification. See in particular paragraph [0077]. As is evident from Collins the selection of poly-crystal or single-crystal embodiments is available to one of ordinary skill in the art and does not lead to any unexpected results. Moreover, the selection of a single crystal rather than a poly-crystal merely removes grain boundaries, and thereby impediments to mobility and life time."

In reply, the Examiner appears to base the rejection on the erroneous finding that Kitabatake et al discloses a method of synthesizing diamond by CVD. Rather, it is clear that that Kitabatake et al disclosed method is of treating already produced CVD diamond **post synthesis**. Consequently, the Examiner's finding, relying on the disclosure at column 1, lines 43-53, that Kitabatake et al discloses a growth environment "which uses inert gas hydrogen instead of nitrogen", and therefore inherently meets at least characteristic (ii), is also erroneous. Thus, the mention of an inert gas is in the context of providing an environment in which a previously synthesized diamond is treated. In order to synthesize diamond by CVD, there must be a carbon source, preferably gaseous such as methane or other carbon containing gas, and there is no disclosure of such a source in Kitabatake et al, further indicating that the method of Kitabatake et al is not a synthesis method, but a post synthesis method.

Furthermore, the complete sentence mentioning "CVD diamond," referred to by the Examiner as supported at column 5, line 65, compares the Raman spectrum of "as deposited and after-light-irradiated diamond thin film by micro-wave CVD". The only evidence provided to support the claims of improvement are Figures 7a and 7b showing the Raman spectrum of the diamond before and after the method of radiation treatment provided. While there is a distinct improvement between Figure 7a and Figure 7b in terms of the Raman spectrum, the improved Raman spectrum in Figure 7b still shows substantial non-diamond carbon (indicated by the peak labeled "G" in Figures 7a and 7b). The implication that "efficiently annihilating defects in the diamond crystals" means that the diamond after treatment is actually defect free, is entirely refuted.

In this regard, the changes shown in the Raman spectrum could easily be entirely surface related, and Kitabatake et al recognizes that the inventors had difficulty in obtaining clean diamond surfaces and that the disclosed method helped to clean them up. Kitabatake et al does not provide any unambiguous data that the bulk of the diamond was improved by the irradiation treatment.

The use of the term "defects" in Kitabatake et al is also misleading, since the patent focuses only on non-diamond carbon and ignores other types of defects such as impurities, dislocations, twins, stacking faults, and isotopic impurities, all of which are important defects discussed in the specification herein, as they reduce the electronic properties of synthesized diamond. Consequently, the Examiner is incorrect in finding that the defects disclosed by Kitabatake et al have any relationship to Applicants' invention as herein claimed.

As the method of Kitabatake et al is not a synthesis method, the Examiner's reliance thereon is improper. Moreover, since Collins is not directed to addressing any of the shortcomings identified above in Kitabatake et al, it is not clear why one skilled in the art

would combine these references. But even if combined, the result would not be the presently-claimed invention.

Sussmann et al does not remedy any of the above-discussed deficiencies in the combination of Kitabatake et al and Collins. Sussmann et al simply discloses a geometry for a detector that uses diamond. Thus, while Sussmann et al would undoubtedly benefit from the diamond material of the present invention, it neither discloses nor suggests the use of diamond having any of the characteristics of the CVD diamond of the present invention. In fact, the only property that is mentioned by Sussmann et al is the charge collection distance and the meaning thereof is unclear as the electric field at which it applies is given as 0.1 V/μm to 3 V/μm (page 7, paragraph 3).

Although the above is sufficient to demonstrate patentability herein, the following is offered in reply to some of the Examiner's other erroneous findings.

The Examiner's finding that "the selection of a single crystal rather than a polycrystal merely removes grain boundaries, and thereby impediments to mobility and lifetime" is a gross oversimplification. Applicants have found that other defects such as dislocations and stacking faults have a large impact on the characteristics of the material and the prevention of the formation of these defects during the synthesis by careful preparation of the substrate, upon which the single crystal CVD diamond is grown, is necessary.

Prior to the present invention, there were no known examples of diamond with the characteristics of the CVD diamond of the present invention. Indeed, the carrier mobilities of the present invention were found to be far higher than were believed possible in diamond. Disclosures in the literature prior to the present invention suggest that diamond might be a good material for electronic devices because of features such as its wide band gap etc, but this was merely a "desirable object", not a disclosure of an actual diamond with the required properties and a method of producing that diamond. The present invention is therefore not a

"mere selection of known materials generally" as such material was not previously known, let alone available.

For all the above reasons, it is respectfully requested that these rejections be withdrawn.

The rejection of Claims 1, 11-13, 31, 33 and 34 under 35 U.S.C. § 112, first paragraph, as failing to comply with the description requirement, is respectfully traversed. The Examiner, in referring to mobility times lifetime, finds that, in effect, the term "a $\mu\tau$ product measured at at an applied field of 50 V/μm and 300 K greater than 1.5 x $10^{-6}cm^2V^{-1}$ where, μ is the mobility and τ is the lifetime of the charge carriers" is not supported by the specification as filed. The Examiner finds that "some dependence on N appears to be included in the written description."

In reply, Applicants pointed out in the previous amendment that support is found at page 3, last paragraph of the specification. Indeed, this paragraph contains verbatim descriptions of all of the parameters listed. See also the description at pages 6-8 of the specification under "b) $\mu\tau$ product." Nor is it understood what the Examiner means by the above-quoted finding, but it is irrelevant. The issue is whether had possession of the recited $\mu\tau$ product limitation as of the filing date. It cannot be disputed that they did.

Accordingly, it is respectfully requested that this rejection be withdrawn.

The rejection of Claim 1 on grounds of non-statutory obviousness-type double patenting over either Claims 4 or 5 of U.S. 7,128,974 (Scarsbrook et al) and the provisional rejection of Claim 1 on grounds of non-statutory obviousness-type double patenting over Claim 5 of copending application No. 11/486,421 (copending application),[1] are respectfully traversed.

[1] As previously pointed out to the Examiner, the copending application has been abandoned in favor of application no. 11/681,840. It is assumed that the provisional rejection will now apply to this application.

The claims of Scarsbrook et al and the copending application all require a thickness of greater than 2 mm. There is no disclosure or suggestion in these claims that any of the recited characteristics recited in the present claims could be achieved at any layer thickness. In addition, Scarsbrook et al and the copending application, on the one hand, and the present application, on the other hand, all have the same effective filing date, i.e., June 14, 2001. Thus, the possibility of time-wise extension of the patent term in the absence of a terminal disclaimer is non-existent.

For all the above reasons, it is respectfully requested that the rejections be withdrawn.

Applicants respectfully submit that all of the presently-pending and active claims in this application are now in immediate condition for allowance. The Examiner is respectfully requested to extend his search to non-elected species. In addition, the non-elected method claims all depend on Claim 1, and are thus rejoinable if Claim 1 is allowable. In the absence of further grounds of rejection, the Examiner is respectfully requested to pass this application to issue.

Respectfully submitted,

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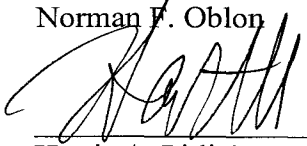

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